Development of an ICT-delivered Control Programme for Use in Aphasia Crossover Intervention Study

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ABSTRACT
Aphasia refers to an acquired loss or impairment of the language system that can occur post stroke. Information and Communication Technologies (ICT) can provide an option for the delivery of intensive aphasia rehabilitation but further research is required to support this. A crossover research design can provide a robust methodology for investigating the effectiveness of an ICT-delivered aphasia rehabilitation programme. However, if using a control programme in a crossover design it must be carefully considered. It should be distinct from the intervention but not easily distinguished as a "sham" programme. This can pose challenges for researchers. The design, development and pilot of a control programme for a crossover aphasia rehabilitation research design is presented here.

Author Keywords
Aphasia rehabilitation; research methodology; control programme development.

ACM Classification Keywords
Human-centered computing~Accessibility design and evaluation methods.

INTRODUCTION
Aphasia refers to an acquired communication disorder that can occur post stroke. A recent systematic review suggests computer-delivered aphasia rehabilitation is effective when compared to no therapy and may be as effective as clinician-delivered therapy for specific conditions[1]. However, the authors conclude that the current quality of evidence is low and highlight the need for further research. A crossover research design is a robust methodology that has been used to evaluate rehabilitation software targeting speech production impairments post stroke[2]. In a crossover design each participant receives both the intervention programme and the non-intervention alternative in a random order and therefore acts as their own control. In ICT-delivered aphasia rehabilitation research an appropriate control programme must be used, ensuring every effort is taken to blind participants to the intervention and control phase. The control programme should be distinct to the intervention (i.e. language rehabilitation) programme in relation to the content[3], but must not be easily distinguished as the "sham" programme. It should have similar layout, interface and levels of challenges within the task items as the intervention programme but distinct content. Our research team aims to evaluate the outcome of a commercially available aphasia rehabilitation programme targeting auditory language comprehension impairments. In order to use a crossover research design, we needed to develop a distinct non-language based programme to act as the control programme. Here we provide an overview of the design, development and pilot of the control programme for the crossover research design.

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METHODS

Programme Design and Development
The language programme in this study provides the participant with a simple interface; images are presented in the top half of the screen in a horizontal line and a button at the bottom center of the screen presents the question. When the participant clicks the button an auditory sentence stimulus will play. This sentence matches one of the image stimuli in the top half of the screen, all others are semantic or grammatical foils. Visual and auditory feedback is provided on accuracy. When participants choose an incorrect stimulus they are provided with feedback on this and an opportunity to try again. The participant can listen to the auditory stimulus as often as they want. The programme is available both as an iPad app and a website.

The research team set about designing and developing a control programme with a similar layout to the target language programme but with non-language activities. Visual matching tasks were initially considered followed by pattern recognition tasks and visual memory tasks. These non-language cognitive tasks were considered as they could fit a similar screen layout and interface to the language programme but were distinct cognitive tasks not expected to effect language. A large assortment of copyright free images was downloaded and modified as needed under Creative Commons CC0 in order to populate the stimuli.

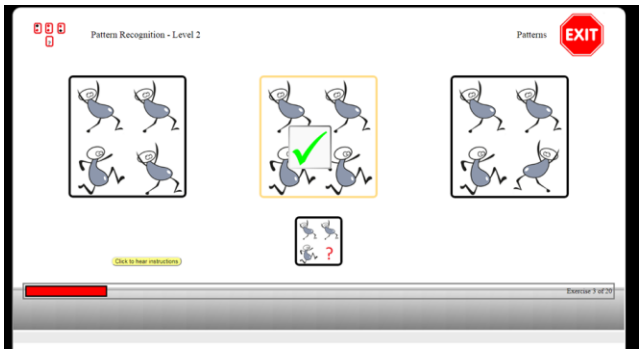

Figure 1. Example of Pattern Recognition Task with correct answer feedback

The stimuli were organized into corresponding items for each of the three tasks (matching, pattern recognition and visual memory) by a member of the research team who had experience creating language and cognitive rehabilitation activities. Each of the three tasks was subdivided into a number of levels with 20 question items in each level. A JSON (JavaScript Object Notation) array was constructed. This allowed one of the researchers, with limited programming experience, to structure and store task information in an organized and easily accessible format. A PHP (PHP:Hypertext Preprocessor) script was run on a secure website which hosted the programme. Programme usage and accuracy data was recorded using MySQL, a database management system. Simple usernames and passwords were set up to allow researchers to identify individual participant data. This data is used by the research team to monitor participant progress in the crossover study. Figure 1. provides a screen shot of one of the programme tasks. In all three tasks the question (image) is presented in the bottom center and the answer is one of the images presented horizontally in the top half of the screen. This interface is similar to the language programme. The programme will run via a weblink on computer, laptop or tablet devices. Participants tap or click on the image to choose their answer to the question at the bottom and are provided with visual and auditory feedback on their accuracy in a similar manner to the language programme.

Piloting the programme in a crossover research design

Ethical approval for the crossover study was obtained from the local Research Ethics Committee. Participants with post stroke aphasia were recruited and randomly assigned to the Language/Control programme or Control/Language programme following baseline measurement. They were provided with a training session and a manual for the allocated programme. Participants were asked to spend a minimum of 5 hours per week working on the assigned programme over two 6-week phases of the research. The 2 phases were separated by a 4-week wash-out period similar to Varley et al.[2]. A mid-phase observation session was completed during week three of each phase. Each participant completed activities on the programme allocated for that phase, and the researcher completed an observation checklist. A feedback questionnaire was then completed. It includes an aphasia accessible version of the Raw NASA TLX which provides a subjective measure of workload, as well as questions related to the ease of use and functionality of the programmes and the level of assistance required.

PRELIMINARY FINDINGS

Five participants from our ongoing study who completed both phases of the research design are reported here; age range 32 - 67 years. Participants presented with a range of aphasia severity from mild to severe as noted by the Western Aphasia Battery Aphasia Quotient range 27.4 - 95.2[4]. Participants were between 4 years 7 months and 7 years 11 months years post stroke.

The Raw NASA TLX scores indicate a medium level of workload for both programmes with control programme mean of 57.5 (SD 34.4) and language programme mean of 51.3 (SD 28.6). A difference between mean Raw NASA TLX scores in the control programme and the language programme of 6.16 (95% CI: -52.27, 39.94) was not statistically significant ($t_{(8)}$=0.274, p=0.615). The remaining questions in the feedback questionnaire investigate level of assistance needed and aspects of functionality, and ease of use of the programmes (ranked on visual analogue scales “no help” = 1, “a lot of help” =5 and “very easy” = 1, “very hard” = 5, a rating of 3 indicates a neutral response). The control programme median 1.57 (IQR 0.47 – 2.67) was lower than the language programme median of 2.42 (IQR 1.5 – 3.36). Statistical analysis is not possible due to the type of data and small sample size. However, the results suggest positive responses in general as the median scores are less than 3. When comparing first and second phase (not accounting for programme type) the difference between mean Raw NASA TLX scores was 4.5 (95% CI: -41.73, 50.74) this is not statistically significant (t(8)=0.225, p=0.828). The remaining questions probing levels of assistance, ease of use and functionality indicate a more positive response during the first phase (median 1.86) compared to second phase (median 2.43). However, both are rated favourably with median scores less than 3.

CONCLUSIONS AND FUTURE WORK

The findings indicate that both the control programme and the language rehabilitation programme have similar perceived workload and there was no difference between phases of research. Therefore, both programmes are perceived to provide equal challenges. Participants rated the control programme somewhat more favourably with respect to ease of use, functionality and requirement for assistance. However, it is important to note that both programmes are rated positively overall. Therefore, the control programme developed for this research fits well with the two-phase experimental crossover research design and will increase the rigor of the methodology. The research exploring feasibility of ICT-delivered aphasia rehabilitation targeting auditory comprehension at sentence level is ongoing.

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REFERENCES

[1] Zheng, C., Lynch, L. and Taylor, N. 2016. Effect of computer therapy in aphasia: a systematic review. *Aphasiology*, 30, 2-3 (March 2016), 211-244. http://doi.org/10.1080/02687038.2014.996521

[2] Varley, R., Cowell, P. E., Dyson, L., Inglis, L., Roper, A. and Whiteside, S. P. 2016. Self-Administered Computer Therapy for Apraxia of Speech: Two-Period Randomized Control Trial With Crossover. *Stroke*, 47, 3 (March 2016), 822-828. http://doi.org/10.1161/STROKEAHA.115.011939

[3] Brady, M. C., Godwin, J., Kelly, H., Enderby, P., Elders, A. and Campbell, P. 2018. Attention control comparisons with SLT for people with aphasia following stroke: methodological concerns raised following a systematic review. *Clin Rehabil* (Jun 2018). http://doi.org/10.1177/0269215518780487

[4] Kertesz, A. 2007. *Western Aphasia Battery (Revised)* PsychCorp, San Antonio.